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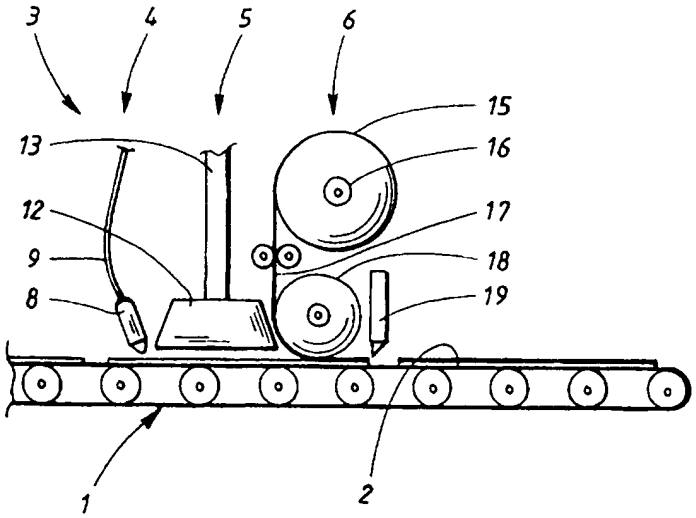

(57) Abstract

Method for gluing and glue for use in the method. As a binder, the glue contains one or several thermosetting plastics from the groups polyester, acrylics or epoxy, and a curing system and additives such as viscosity-lowering levelling aids and adhesion-promoting agents. The glue is prepared as powder and is applied on one or both gluing surfaces in a dry state and is heated to a tacky state, so that it adheres to the coated surface. Finally, the surfaces are pressed together with the partly or completely melted glue in between. The curing is carried out while maintaining such a temperature, adapted to the curing properties of the glue, during an adapted time, that curing of the included thermosetting plastic or plastics takes place, alternatively by exposing the applied, tacky glue to curing-initiating radiation immediately before the pressing together.

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TITLE:
Method for gluing, device for carrying out the method and glue composition for use in the method.

TECHNICAL FIELD:
The present invention relates to a method for gluing and a device and a glue composition intended to be used for the gluing according to the method.

STATE OF THE ART:
The agglutination of surfaces requires a substance, the glue, which may be brought to a first, tacky state, so that the glue adheres to the surfaces which are to be joined. When the surfaces have been united with the glue between them, the glue is converted to a more or less solid state, whereby the glue joint obtains its final tenacity towards rupture of the joint. The difference in cohesive force between the first and the second state may be extremely different.

Certain glues, such as urea-formaldehyde resin glues, have a very low cohesive force in the first state but provide a strong joint when the glue has hardened. Other glues, such as contact adhesives, provide a joint of a considerable strength immediately after the surfaces have been joined, but thereafter the strength of the joint does not increase very much.

The conversion from the first to the second state may, depending on the type of glue, occur in many different ways. In the first state, many glues are a tacky mass, which solidifies by means of the evaporation of a solvent. Such solvents are often non-environmentally friendly; volatile hydrocarbons are common. Other glues are hard at

room temperature and are converted to a tacky state by heating. However, the utilization of a phase change in this way will normally give limited strength to the finished glue joint. In many cases, furthermore, it is not rational to work with a glue which has to be kept heated during the gluing operation. There are additional glue types and systems, which start from natural products or from more conventional chemical products or systems.

Another branch of glue technology is represented by polymeric materials. Thermoplastic systems, which are brought to a tacky state by heating and to a solid state by cooling down, do not in principle differ particularly from conventional systems with a corresponding process course. Systems with thermosetting plastics, on the other hand, represent a special branch of glue technology. Such plastics may be given a plurality of states, from thinly fluid, through viscous tacky masses, to a solid state as foils, which are converted to a tacky state by heating during the gluing process itself. After the gluing surfaces have been brought together, the glue is, by means of curing of the plastic, converted to a solid state from the first state with a more or less fluid consistency. This requires initiation of the curing, which may occur in different ways depending on the type of thermosetting plastic and its components. An addition of a chemical hardener is often used which, however, has the disadvantage that the gluing process has to be performed within a limited time and that difficulties arise when it comes to cleaning the utilised vessels and tools if the plastic is allowed to cure on these.

Thus, there are both disadvantages and limitations with the use of thermosetting adhesives since, in many cases, they may be less rational to use in industrial production than other gluing systems. In many respects, however, they

possess superior properties when it comes to the strength of the glue joint, long lifetime towards ageing and small influence on the strength when heated within the temperature range during use. A further advantage is that the curing does not give any emission of environmentally harmful substances, which is the case when glues with solvents are concerned.

SUMMARY OF THE INVENTION:

The present invention has as an object to provide a gluing method, which starts from a thermosetting resin glue, which is also comprised by the invention. The object is to achieve a method which is very rational to carry out in industrial production, whereby the glue in question is very convenient to handle. At the same time the earlier mentioned advantages, which are associated with thermosetting adhesives, are gained, namely high strength and heat resistance of the glue joint and the absence of emissions of substances which are dangerous to the environment during the gluing.

This is achieved since the glue is manufactured in a pulverous state and may be in this state right up to the start of the gluing process. The entire handling, including the application of the pulverulent glue, may consequently be done with a dry product and, as such, no storage vessels or tools for the handling and application of a tacky mass are required, so that a very rational method thereby is obtained.

DESCRIPTION OF THE DRAWINGS:

The method and the glue according to the invention are described in the following. Thereby, reference is made to two specific gluing processes which are illustrated in attached drawings by schematic representations of each process equipment, as is shown in Figs. 1 and 2, respectively.

PREFERRED EMBODIMENT:

The description of methods according to the invention will start with an account of a gluing process performed in process equipment which is schematically shown in Fig. 1. In this case, the process relates to the gluing of a film to steel plates. The resulting product is panels intended to be used as a wall covering. One extensive field of use is as a wall covering in ships, train carriages etc., and also in buildings, especially in prefabricated ones. In the drawing, reference numeral 1 denotes a conveyor belt on which steel plates 2, in a consecutive order, may be conveyed forwards, from left to right in the drawing. The plates thereby pass a laminating mill 3. This comprises, seen in the direction of transport, a glue application station 4, a heating station 5 and a laminating station 6.

The application station 4 for the pulverulent glue is herein shown to consist of one or several powder spray guns 8, arranged for electrostatic charging of the powder. In order to cover the full width of the plates 2, one or several of the guns may be arranged for movement back and forth in the transverse direction of the plates. Hereby, it is assumed that the plates are electrically conductive, they may for instance be made of steel or aluminium, and earthed, which is achieved by the plates lying on the conveyor belt 1 which in turn is connected to earth. The guns 8 are supplied with powder and pressurized air for the spraying via one or several conduits 9.

The heating station 5 is hereby shown as a hood 12 over the conveyor belt. It is arranged for convection heating by means of the supply of heated air through a conduit 13.

The laminating station 6 is supplied with the film which is to be glued to the plates from a roll 15 which is rotatably suspended on a shaft 16. A film web 17 runs from the roll

to the nip between the plate 2, which is to be laminated, and a press roller 18. After the press roller there follows a film cutting member 19.

The laminating plant is very schematically shown and described as one embodiment amongst many alternative embodiments. Thus, the plant may be arranged for continuous lamination of a long plate web, which is fed from a roll and which is cut into suitable lengths for use after the lamination. The pulverulent glue may be applied in another way than by spraying even if this is an advantageous method. The heating may, besides by hot air, be done by infra-red heat or contact heating of the plates. Also heating by means of induction is a possible alternative.

In the shown embodiment, the plates 2 are gradually advanced on the conveyor belt 1 and firstly meet the glue application station 4 at which the surface of the plate is sprayed with the electrically charged glue powder. A layer of this sticks to the surface of the plate which is earthed, and is retained thereon by electrostatic forces. In the heating station 5 the plate is exposed to the hot air, which should hit the plate at a low speed in order not to blow the powder away. By means of the heating, the plate should reach a temperature of 250 °C before it reaches the spot where the film web 17 is pressed into contact with the plate by the press roller 18. When the plate has passed the press roller, the film web is cut at 19, which may be done by means of cutting/shearing or by means of heat which melts the film along a line. At the same time, a new plate is brought in beneath the roller 18 and the operation is repeated.

The earlier mentioned temperature is so adapted that the glue powder is melted so that it sticks to the two united surfaces. Immediately thereafter, the powder, which as

earlier mentioned consists of a thermosetting plastic, is cured. A temperature of 250 °C has proved to be applicable for the composition which will be described in the following. At the same time, the temperature allows lamination without the film being damaged. Here, it is namely assumed that the film is a plastic film with a melting temperature which is just above said value. When material compositions other than a plastic film are concerned, such as PVC laminated on a metal plate, it may be necessary to choose a lower temperature in order not to damage the materials. In such cases, the powder composition must also be adapted to melting and curing at such a lower temperature.

Certain method steps, which represent the principles of the method, are evident from the described embodiment. These steps are:

1. Preparing a glue composition which completely, or to a considerable extent, consists of an uncured, thermosetting plastic, which in this state and in a temperature range around about room temperature, adopts a solid state, while at a raised temperature, for instance 80-300 °C, by means of melting it forms a tacky mass with adherence to surfaces which are to be glued.

2. Preparing the glue composition for use, to a dry powder with the composition so adapted that the powder can be given an electrostatic charge.

3. Preparing the gluing surfaces in order to provide for the adhesion of the glue to these. The surfaces should of course not be dusty, dirty or greasy, something which in general is valid for all gluing. In certain cases, it may also be necessary to remove traces of oxide, rust or embers from the surfaces. Despite such basic pre-treatment, it may

be advantageous for the strength of the glue joint if the surfaces are pre-treated. When steel plate is the substrate, chromating has been shown to be of value. In other cases, the application of a primer may be convenient. This may contain an organic component in order to obtain a good affinity to the thermosetting plastic in the glue. For environmental reasons, solvent-based coatings should be avoided, whereby water-based compositions may be an alternative. Another alternative may be that the primer coating is also done by powder coating.

4. The powder glue is given an electrostatic charge. The purpose is partly to give the powder particles a uniform distribution in the room during the application process so that the powder particles coat the gluing surface with an even layer, and partly in order to get the powder particles to adhere to the glue surface until such heating has occurred that the powder sticks to the gluing surface. The last mentioned effect, that the powder particles should be retained on the gluing surface by electrostatic forces, presupposes that a difference in potential may be maintained between the charged powder and the gluing surface. As mentioned earlier, this may occur if the substrate is electrically conductive and earthed during the application. When non-conductive objects, such as chipboard as a substrate, are concerned it may be necessary to resort to methods other than the one mentioned, for instance coating the surface of the substrate with a conductive varnish, moistening the surface of the substrate or pre-heating to such a temperature that the powder particles adhere by melting in the interface towards the substrate.

5. Applying the glue powder on at least one of the surfaces which are to be agglutinated. Application by means of spraying from guns which give an electrostatic charge

before the spraying with pressurized air, is a well-tried and advantageous method.

6. Heating to such a temperature that the powder melts in order to stick to the gluing surfaces. As mentioned in the example, the heating may occur by means of the object, in this case the plate, being heated to the required temperature so that the melting temperature of the powder may be reached and maintained in connection with the application of the non-heated film. In other cases it may be convenient to heat both components which are to be joined. When objects having a larger mass are concerned, such as boards of a larger thickness, through-heating does not have to be practised but only surface-heating. Thus, heating by means of infra-red radiation may be a suitable method, possibly in combination with hot-air heating. Objects which conveniently should be through-heated may be heated before the gluing, for instance in an oven.

7. Joining the gluing surfaces while maintaining such a temperature that a curing of the powder takes place in direct connection to the joining. The means for obtaining a strong glue joint is a joining with a raised surface pressure, and of course while ensuring that no air cushion is formed between the surfaces. A lengthy pressing together of the surfaces is, however, not required. If the appropriate parameters for the gluing method have been chosen, a very rapid curing of the thermosetting plastic in the powder is obtained.

After this description of the method, both in a specific embodiment as well as in its general form, a description of a preferred glue composition now follows.

The main components of the glue should be one or several polymers or co-polymers of a thermosetting type, systems

for initiation of the thermosetting and whenever applicable fillers, particularly applicable when uneven surfaces, which do not come into complete contact with each other, are concerned, pigments for colour adjustment, especially at joints where the glue partly becomes openly visible or perceptible by means of a certain transparency of the substrate, and additives for increasing the strength of the glue joint and/or in order to facilitate the gluing process. Below, components which are useful in this context are listed.

Examples of components:

Thermosetting plastics:

- Polyester (hydroxy-functional polyester)
- Polyester (acid-functional polyester)
- Acrylic (hydroxy-functional polyester)
- Acrylic (acid-functional acrylate)
- Acrylic (epoxy-functional acrylate)
- Epoxy (Bisphenol-A type)
- Epoxy (Novolac-type)

Hardeners:

- Blocked IPDI derivative
- IPDI-uretidione
- TDI derivatives
- TMXDI and other polyisocyanates
- Triglycidylisocyanurate
- Melamines
- Glycouriles
- Hydroxy-alkylamides
- Glycidylbased compounds
- Derivatives of dicyandiamide
- Modified aromatic and aliphatic polyamines
- Polyphenoles
- Acid anhydrides

Amino resins (melamine, benzoguanamine, glycoluryl)

Other additives:

Additives:

Accelerators, Benzoin, Flow additives, Wetting agents, Flatting agents, Waxes, Adhesion promotors

Fillers:

Inorganic compounds such as $BaSO_4$, $CaCo_3$, $CaSiO_3$, Dolomite, Talc, Mica

Pigments:

Inorganic, organic, TiO_2

When composing a specific glue, the components suitable for the prevailing conditions are selected from the conceivable components in each group. Accordingly, determining factors are the adhesion between the gluing surfaces in question and the glue, the physical shape of the surfaces, the possibility of a tight or less tight fit-up, smoothness etc., possible absorption of the substrates such as when fibrous materials are concerned, permissible melting and curing temperature, possible limits are 80° and 300 °C, desired curing time whereby possible times lies within the range 5 seconds to 5 hours, and requirements concerning the agglutinated objects, such as strength of the joint, resistance to fatigue, flexibility from hard as glass to elastomer-like and resistance to both low and high temperatures.

As is evident, one or several thermosetting plastics are selected for the binder system, from one or several of the groups polyester, acrylic or epoxy with a thermo-initiating hardener adapted for curing at a predetermined temperature and curing time. Depending on the circumstances, important

additives are accelerators when a shortened curing time is desired, flow additives in order to obtain a suitable viscosity when pressing together the gluing surfaces, thus additives which are dependent on the process requirements, and wetting agents and adhesion promotors in order to achieve increased adhesion which is particularly important for voidless, shiny materials which are difficult to wet, for instance glass. Pigments as well as flatting agents are as earlier mentioned, in the main, based on appearance requirements. The fillers are not chemically active in this context, but are important where a filling of cavities in the joint is necessary.

The strength of a glue joint depends on the tenacity of the glue and its adhesion to the gluing surfaces. When a thermosetting plastic is concerned, the adhesion is normally the most critical. In the present context, the co-polymer Methyl-vinylester - Maleic anhydride has been found to be an effective adhesion promotor, particularly when polyester as a binder system is concerned.

Specific for the described and disclosed method is that the pieces which are to be joined may be heated to the temperature which is required for the curing of a thermosetting adhesive, normally about 200 °C. This may be realized without difficulties in the process which has been mentioned, namely laminating, where both parts are in the form of thin layers, which can easily be through-heated by the supply of heat from outside. Since at least one of the layers is pliable, heat can easily be supplied in the gap which is formed between the two surfaces, if the pliable layer is successively, conveniently by rolling, applied onto the piece which is to be laminated. Such lamination does not have to imply that two elongate webs or at least one elongate web is necessary, as in the described process, and provides the possibility of a continuous process. It is

also possible with individual pieces of laminating layers and carrier layers if the laminating layer is kept bent upwards and is successively pressed down against the carrier layer.

There are, however, work pieces and conditions in which the described process cannot be practised. This is especially valid for stiff pieces such as hard plates, which cannot be joined successively while being bent up, and pieces which are difficult to heat to the curing temperature of a thermosetting adhesive. The latter limitation may be due to the fact that the material of one or both the pieces does not allow a heating to the curing temperature since they may melt or be deformed, or because the mass is so large, when thick pieces are concerned, that a through-heating would be far too energy-consuming. Therefore, an alternative method will be described herein, which enables gluing with a pulverous thermosetting plastic also during said conditions. Thus, reference is made to Fig. 2. The method is based on preparing the glue to have a low melting temperature, which is adapted to the temperature endurance of the work pieces. By means of a suitable composition of the glue, a melting point below 100 °C may be reached. This temperature is sufficient only in order to get the glue into a melted and sticky state, but not in order to cause it to cure. Instead, the glue is composed with a curing system which gives curing by means of electro-magnetic radiation, preferably ultraviolet radiation (UV-radiation). Also, other electro-magnetic radiation such as gamma radiation may initiate curing if the curing system of the glue is designed therefor.

Curing by radiation occurs in a very short time, times down to one or a few seconds may be reached, which is considerably faster than when thermosetting is concerned. Since such radiation cannot reach into the glue joint, when

non-transparent work pieces which have been joined are concerned, the irradiation must take place while the work pieces are separated. Consequently, the curing time of the glue must be adapted so that the work pieces can be joined before curing begins. These requirements may be met by means of a method according to the following specification:

1. Preparation of the glue composition from an uncured thermosetting plastic so that it, at a moderately raised temperature assumed to be below 100 °C, by melting from a solid state forms a tacky mass with adhesion to the surfaces which are to be glued. The glue composition is arranged not to cure at said temperature but to cure when exposed to electro-magnetic radiation such as UV-radiation.

2. Preparation of the glue composition as a dry powder which may be given an electrostatic charge.

3. Preparation of the gluing surfaces in order to provide for the adhesion of the glue thereto.

4. Heating of at least the surface layer of at least one of the objects which are to be agglutinated to such a temperature that, when powder is applied, it reaches said temperature level where melting to a tacky state occurs. Since the applied powder might not completely adopt the temperature of the surface, and since a certain cooling may take place, it may be presumed that the surface temperature must be a little higher than the temperature at which the powder melts, but not so high that thermal curing of the plastic arises.

5. Application of the glue powder on the surface or at least on one of the heated surfaces. Thereby, the powder is preferably provided with an electrostatic charge for distribution of the powder. If the surfaces have another

potential or polarity in relation to the powder, the distribution of the powder may at the same time, to a great extent, be limited to such surfaces.

6. Exposing the applied and, by means of heat conduction from the coated surface, melted powder to electromagnetic radiation so that curing is initiated. The powder must, however, be adapted so that curing does not begin at once and before the next moment has been performed.

7. Joining the gluing surfaces under compression before curing takes place (see above).

The powder which is to be used is primarily of the same type which has been described for the thermo-setting method. However, the powder must be adapted for radiation-curing by containing curing initiators or such a polymer system, which in itself is initiated by the chosen radiation. Particularly for curing with UV-radiation and with a powder which melts at said low temperature, the following composition may be adopted:

The main component of the powder is to 50-<100% an unsaturated polyester, amorphous or crystalline. Furthermore, a hardener is preferably included in order to obtain increased cross-linking during the curing stage. This hardener may be an aromatic urethane diacrylate oligomer, a triacrylate of trihydroxy-ethylisocyanurate, a vinyl ester, an oligomer acrylourethane or something similar, to 15-50%. An addition of a photoinitiator is required in order to initiate the curing stage. This addition may vary between 1-3%. For a clear varnish, it is advantageous to use a 1-hydroxy-cyclohexyl-ketone as a photo-initiator, and for white pigmented systems 2,4,6-trimethylbensoyl-diphenyl-phosphineoxide may be used. This is however only specified as an example and completely

different photo-initiators may be needed for particular purposes. An addition of a levelling agent is also presumed. 1-3% of this is recommended. As a levelling agent e.g. acrylates may be used.

Basic recipe for a composition which provides good levelling-out after melting at low temperatures and a good solvent resistance.

Unsaturated polyester	70-85%
Hardener	15-30%
Photo-initiator	1-3%
Levelling agent	1-3%

The melting temperature of the powder should, at the most, be 80-90 °C in order to ensure that a wooden component is not damaged during the melting phase. The melting should take place by means of IR-heat or a combination of IR- and convection heat. This implies that the melting phase, at such relatively high temperatures as these, does not have to be in progress during an especially long time since IR rapidly heats the wooden components to the desired temperature. A few minutes may be assumed to be what it is needed, but is very much dependent on the material which is to be coated. Certain wooden materials are very sensitive to a rapid heating and experience a strong degassing, which might entail that a slower and more careful heating method must be selected.

By way of example, a device for carrying out the described method is shown in Fig. 2. Here it is assumed that two stiff slabs 22 and 23 are to be agglutinated. The slab 22 is placed at the bottom and on a fixed table 24. The slab 23 is supported by a plate 25 by means of suction cups 27, which are under negative pressure since they are connected

to a suction pump by means of conduits 28 (only one suction cup with a conduit is shown in the drawing).

The plate 25 is supported by an yoke 29, which in turn is supported by a power device 30 such as a hydraulic cylinder (only partly shown). By means of this device, the slab 23 may be kept in a raised position above the slab 22 so that a space is formed between the opposing surfaces. By means of the power device 20, the slab 23 may be lowered and pressed against the slab 22 with said surfaces pressed against each other.

Rails 32 travel along both sides of the table 24 (only the ends are shown). A wagon 33 may run on these rails. It is exposed on both sides to directed rays 34 for heat radiation, infrared light. A feedable cable (not shown) for current supply to the rays is arranged. A second wagon 36 is also arranged to run on the rails. It supports a number of powder spray nozzles 37 which are arranged so that the complete surface of the lower slab 22 may be coated with powder. It is also conceivable that the upper surface be coated with powder by means of spray nozzles which are directed upwards. As mentioned earlier, it is advantageous if the powder is electrostatically charged and thereby receives a uniform distribution before it reaches the surface. It has also been mentioned that if the surfaces may obtain another potential than the powder, they will attract the same, so that the distribution outside the surfaces which are to be coated is limited.

Furthermore, the device is provided with radiators for ultraviolet light, which are marked with circles 39. The intention is that the UV-light shall reach the surfaces which are coated with powder. Since the space between the surfaces of the slabs may be relatively narrow, a good light distribution must be provided. This may be achieved

by means of a plurality of radiators around the slabs or, alternatively, the radiators may also be located on a wagon which may be moved on the rails 32.

Gluing in the described device takes place such that after the slabs 22 and 23 have been supplied and the slab 23 has been lifted by negative pressure inside the suction cups 27, the wagon 33 with the heat radiators 34 is passed through the space between the opposing surfaces of the slabs. The intensity of the heat rays and the speed of the wagon are so adapted that at least the surface layer of the slabs receives heating to the earlier mentioned temperature level. The heating may be supported by means of blowing in heated air; the device for this is, however, not shown. On the whole, the heating is adapted to the nature of the objects which are to be agglutinated, and to the extension of their surfaces etc. In certain cases, solely heating or heat radiation is to be preferred. In other cases, convection heating by means of heated air is to be preferred, and in many cases a combination is probably the most convenient.

When the surfaces have obtained a sufficient heating, the wagon 36 is brought into the space between the slabs and at least one surface is coated with powder. This will then melt and thus adhere to the coated surface. Therefore, it is also possible to coat the surface facing downwards, without the powder falling off, even if retention by means of electrostatic forces would not be utilized.

The surfaces are now coated with the thermosetting plastic glue which has adopted a melted and tacky state. While this state still is maintained, the glue-coated surfaces are subjected to the ultraviolet radiation by means of the radiators 39 or, as earlier mentioned, radiators on an additional wagon. This must be done very quickly so that

the gluing surfaces may be joined by means of activation of the power device 30 with the plate 25 being lowered and compressing the two slabs. After initiation by the radiation, the curing namely starts rapidly and therefore a rapid sequence of the irradiation and the compression is required.

The embodiment described in connection with Fig. 2 only constitutes an example. It must be adapted to different types of objects and surfaces which are to be agglutinated. Important are, however, the main elements of heating, coating with powder and melting of the same, and irradiation in order to initiate the curing and immediately thereafter pressing the surfaces together.

The described device only shows an example of how the method in its second embodiment may be carried out with the use of UV-curing powder. The method in this form may for instance also be applied to a gluing corresponding to the first embodiment shown in Fig. 2. If the ingoing lamination materials are not suitable to heat to the temperature for thermo-setting, one or both layers may be heated to the lower temperature. The powder is applied to at least one of the layers before the layers meet, so that curing starts at a distance from the nip near by the roller. Within this distance the curing is initiated by emitting a focused band of UV-radiation or other applicable electromagnetic radiation.

CLAIMS:

1. Method for gluing by using a glue based on one or several thermosetting plastics, which glue is applied to the intended glue joint in an uncured state, and is subsequently cured while compressing the joint, c h a r a c t e r i z e d i n that the glue as a binder system is composed to contain one or several thermosetting plastics such as from the groups polyester, acrylic or epoxy, in that an initiatable curing system is arranged and that one or several additives are added, preferably in the form of viscosity-lowering levelling agents and adhesion promotors adapted to the material and the nature of the gluing surfaces, whereby the method comprises the following steps:
- preparing the glue as a powder;
- applying the powder in a dry state to one or both gluing surfaces;
- heating the glue to a tacky state so that it adheres to the surface where applied;
- pressing the surfaces together with the completely or partially melted glue in between; and
- initiating curing of the thermosetting plastic or plastics comprised therein.

2. The method for gluing according to claim 1, c h a r a c t e r i z e d i n that the pulverous glue is applied in an electrostatically charged state while maintaining a potential/polarity difference in relation to the gluing surface in question, so that the glue powder is retained by means of electrostatic forces until its melting and, by that means, adhesion have been attained.

3. The method for gluing according to claim 1 or 2, characterized in that at least one of the objects which are to be agglutinated is heated, for instance by heat radiation, and/or convection heating, in order to reach the required melting temperature.

4. The method for gluing according to any one of claims 1, 2 or 3, characterized in that curing is initiated and accomplished by heating the glue, together with a material region adjacent the gluing-surface in question, to the curing temperature of the included thermosetting plastic.

5. The method for gluing according to claim 4, characterized in that at least one (18) of the two objects, bearing the surfaces which are to be agglutinated, has such a flexible form that during the agglutination it may be bent upwards with its surface away from the surface of the other object in order to successively be pressed against this surface, whereby at least one object is heated and the glue powder is brought into the nip between the two surfaces where they are pressed together while the surfaces are continuously joined.

6. The method for gluing according to any one of claims 1, 2 or 3, characterized in that the glue powder is applied on at least one of the surfaces which are to be agglutinated, and in that the material region adjacent said surface is heated to a temperature limited in such a way that the glue powder in contact with the surface melts but is not heated so that it cures, in that the coated surface or surfaces thereafter are subjected to electromagnetic radiation, such as ultraviolet radiation, which initiates curing of the powder prepared for radiation-initiated curing, whereafter the surfaces are

joined before the initiated curing is completed, so that the surfaces, when pressed together, adhere to each other by means of the tackiness and are kept together by the subsequently cured thermosetting plastic.

7. The method for gluing according to claim 6, characterized in that the gluing surfaces, before application of the glue powder, are heated by means of heat radiation and/or convection by heated air, directed towards the surfaces.

8. Device for carrying out the method according to any one of the claims 1-3 and 6 or 7, characterized in that it is arranged with means (24,25) for maintaining the objects (22, 23) which are to be glued with their surfaces, intended to be agglutinated, separated from each other by a gap, in that there are means (34) for heating the surfaces, such as for heating by heat radiation and/or convection, in that there are means (37) for bringing powder into the gap so that it coats at least one of the surfaces which are intended to be agglutinated, and means (39) for exposing the surface or the surfaces coated with powder glue to curing-initiating radiation, such as ultraviolet radiation, and in that the means (24, 25) which hold the objects (22, 23) are arranged to be displaced in relation to each other, so that the surfaces intended for agglutination are pressed together, in addition to which control means are arranged to activate the means for heating and for powder coating of the surfaces and thereafter the means for curing-initiating radiation, and finally the holding means for joining the surfaces intended for gluing.

9. The device according to claim 8, characterized in that the means (34) for heating the surfaces are arranged in a mobile way in order

to be brought into said gap between the surfaces intended for gluing, and in that the means (37) for coating the surfaces with powder likewise are arranged to be brought into said gap during the powder coating.

10. Glue composition for use in the method according to any one of claims 1-5,
c h a r a c t e r i z e d i n that it contains one or several thermosetting plastics from the groups polyester, acrylic or epoxy as a binder system, and a thermo-initiated curing system together with one or several additives, preferably in the form of viscosity-lowering levelling agents and adhesion promotors adapted to the material and nature of the gluing surfaces, whereby the glue is prepared for use as a dry powder having a melting and curing temperature adapted to be melted and thermoset in the gluing method.

11. Glue composition for use in the method according to any one of the claims 1-6 and 6 or 7,
c h a r a c t e r i z e d i n that it is composed to have a melting temperature principally not exceeding 100 °C and preferably within the range 60-100 °C, and to be curable by electromagnetic radiation, preferably ultraviolet radiation.

12. Glue composition according to claim 11,
c h a r a c t e r i z e d i n that it is composed of at least one polymer as a main component, a photo-initiating system for bringing the polymer to curing by ultraviolet radiation, and a levelling agent in order to reach said low melting temperature.

13. Glue composition according to claim 12,
c h a r a c t e r i z e d i n that the main component, which is preferably an unsaturated polyester, is included

up to a percentage of about 70 to close to 100%, a hardener up to about maximum 30%, photo initiators to about 1-3%, and levelling agents about 1-3%.

14. Glue composition according to any one of claims 10-13, characterized in that the co-polymer Methylvinylether-Maleicanhydride is included as an adhesion promotor.

AMENDED CLAIMS

[received by the International Bureau on 07 May 1997 (07.05.97); original claims 1-14 replaced by new claims 1-11 (4 pages)]

1. Method for gluing surfaces together by using a glue based on one or several thermosetting polymers, the method comprising the following steps:

- preparing the glue as a powder;
- applying the powder in a dry state to one or both surfaces, which are to be glued together,
- heating the glue to a tacky state so that it adheres to the surface where applied;
- pressing the surfaces together with the completely or partially melted glue in between; and
- initiating curing of the thermosetting polymer or polymers comprised therein by further heating of the glue,

c h a r a c t e r i z e d i n that at least one (18) of the two objects, bearing the surfaces which are to be glued together, has such a flexible properties that during the gluing process it may be bent with its surface away from the surface of the other object (2) in order to successively be pressed against this surface, whereby the glue powder is applied into the nip formed between the two surfaces at the borderline between the area, where they are pressed together, and the area, where they are still bent away from each other, and that at least the one object is heated to bring the glue applied to cure where the surfaces are pressed together.

2. The method for gluing according to claim 1, c h a r a c t e r i z e d i n that the pulverous glue is applied in an electrostatically charged state while maintaining a potential/polarity difference in relation to the gluing surface in question, so that the glue powder is

retained by means of electrostatic forces until its melting and, by that means, adhesion have been attained.

3. Glue composition for use in the method according to any one of claims 1, 2, c h a r a c t e r i z e d i n that it contains one or several thermosetting plastics from the groups polyester, acrylic or epoxy as a binder system, and a thermo-initiated curing system together with one or several additives, preferably in the form of viscosity-lowering levelling agents and adhesion promotors adapted to the material and nature of the gluing surfaces, whereby the glue is prepared for use as a dry powder having a melting and curing temperature adapted to be melted and thermoset in the gluing method.

4. Method for gluing surfaces together by using a glue based on one or several polymers, the method comprising the following steps:
- preparing the glue as a powder;
- applying the powder in a dry state to one or both surfaces, which are to be glued together,
- heating the glue to a tacky state so that it adheres to the surface where applied;
- pressing the surfaces together with the completely or partially melted glue in between; and
- initiating curing of the polymer or polymers comprised therein, c h a r a c t e r i z e d i n that the glue is composed to have a melting temperature principally not exceeding 100° and preferably within the range 60-100°, and to be curable by electromagnetic radiation, preferably ultraviolet radiation, whereby the glue powder is applied on at least one of the surfaces which are to be agglutinated, and in that the material region adjacent said surface is heated to a temperature limited in such a way that the glue powder in contact with the surface melts but is not heated so that it cures, in that the coated surface

or surfaces thereafter are subjected to electromagnetic radiation, such as ultraviolet radiation, which initiates curing of the powder prepared for radiation-initiated curing, whereafter the surfaces are joined before the initiated curing is completed, so that the surfaces, when pressed together, adhere to each other by means of the tackiness and are kept together by the subsequently cured polymer or polymers.

5. The method for gluing according to claim 4, characterized in that the gluing surfaces, before application of the glue powder, are heated by means of heat radiation and/or convection by heated air, directed towards the surfaces.

6. Device for carrying out the method according to any one of the claims 4 or 5, characterized in that it is arranged with holding means (24, 25) for maintaining the objects (22, 23), which are to be glued together with their surfaces, separated from each other by a gap, in that there are means (34) for heating the surfaces, such as for heating by heat radiation and/or convection, in that there are means (37) for bringing powder into the gap so that it coats at least one of the surfaces which are intended to be agglutinated, and means (39) for exposing the surface or the surfaces coated with powder glue to curing-initiating radiation, such as ultraviolet radiation, and in that the means (24, 25) which hold the objects (22, 23) are arranged to be displaced in relation to each other in order to press together the surfaces intended for agglutination in addition to which control means are arranged to activate the means for heating and for powder coating of the surfaces and thereafter the means for curing-initiating radiation, and finally the holding means for joining the surfaces intended for gluing.

7. The device according to claim 6, characterized in that the means (34) for heating the surfaces are arranged in a mobile way in order to be brought into said gap between the surfaces intended for gluing, and in that the means (37) for coating the surfaces with powder likewise are arranged to be brought into said gap during the powder coating.

8. Glue composition for use in the method according to any one of the claims 4 or 5, characterized in that it is composed to have a melting temperature principally not exceeding 100 °C and preferably within the range 60-100 °C, and to be curable by electromagnetic radiation, preferably ultraviolet radiation.

9. Glue composition according to claim 8, characterized in that it is composed of at least one polymer as a main component, a photo-initiating system for bringing the polymer to curing by ultraviolet radiation, and a levelling agent in order to reach said low melting temperature.

10. Glue composition according to claim 9, characterized in that the main component, which is preferably an unsaturated polyester, is included up to a percentage of about 70 to close to 100%, a hardener up to about maximum 30%, photo initiators to about 1-3%, and levelling agents about 1-3%.

11. Glue composition according to any one of claims 8-10, characterized in that the co-polymer Methylvinylether-Maleicanhydride is included as an adhesion promotor.

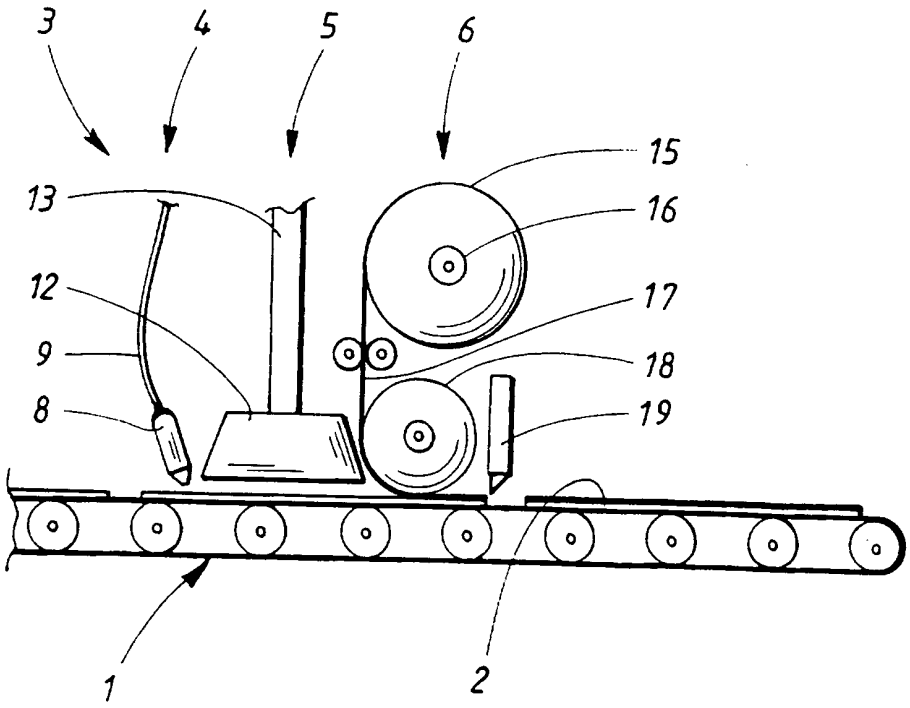

FIG. 1

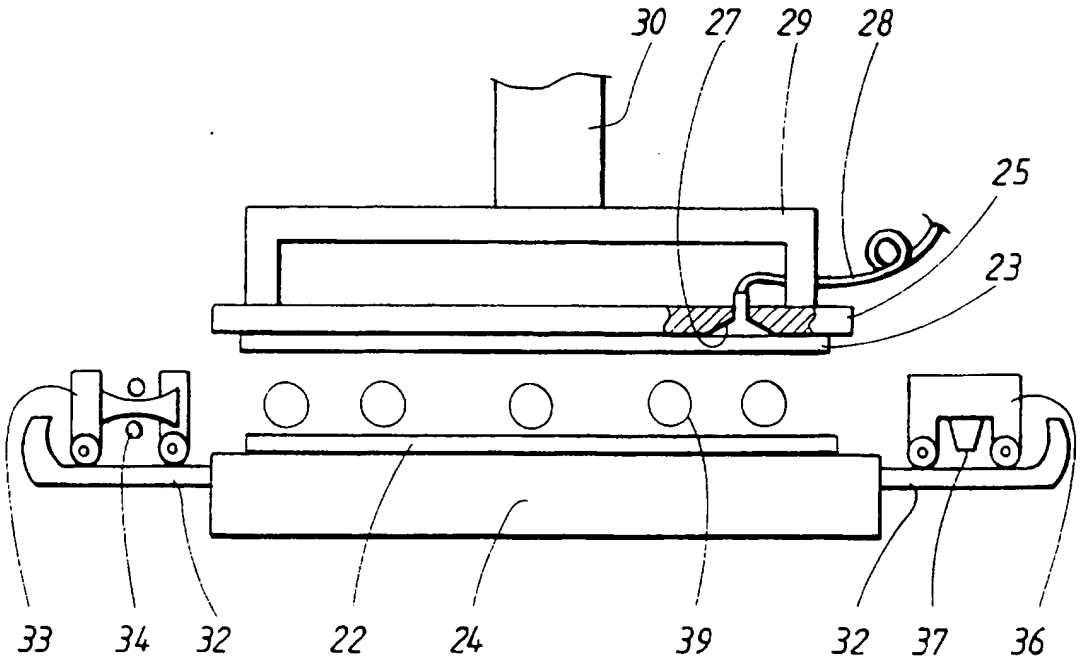

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01642

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C09J 5/06, B29C 65/02, B05D 5/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C09J, B29C, B05D, F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0557657 A1 (BORG-WARNER AUTOMOTIVE TRANSMISSION AND ENGINE COMPONENTS CORPORATION), 1 Sept 1993 (01.09.93), abstract, page 3, line 21 - line 34, page 4, line 14 - line 30, claims --	1-14
X	DE 3938376 A1 (BEIERSDORF AG), 23 May 1991 (23.05.91), abstract, column 2, line 48 - column 3, line 10, claims --	1-14
A	EP 0490136 A2 (BEIERSDORF AKTIENGESELLSCHAFT), 17 June 1992 (17.06.92) -- --------	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 March 1997	27 -03- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Sofia Nikolopoulou Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

04/03/97

International application No.
PCT/SE 96/01642

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0557657	01/09/93	AU-A- 3033292	02/09/93
		CA-A- 2086147	29/08/93
		JP-A- 6025438	01/02/94
		US-A- 5281481	25/01/94
DE-A1- 3938376	23/05/91	NONE	
EP-A2- 0490136	17/06/92	DE-A- 4039636	17/06/92
		DE-D- 59105383	00/00/00
		ES-T- 2072518	16/07/95
		JP-A- 5065468	19/03/93
		US-A- 5434211	18/07/95